

**A Data Acquisition Method of Non-Real Time Transmitting  
Seismic Data Acquisition System Applied in Mountainous  
Area**

**TECHNICAL FIELD**

This invention relates to the fields of petroleum seismic exploration, geology, acquisition of seismic data for coalmine resources, and detecting earthquake.

**BACKGROUND OF THE TECHNOLOGY**

Following the development of the technology of geophysical exploration, seismic prospecting is towards to higher mountainous regions in which it is more difficult to work and all remote transmission seismic apparatus of real time transmitting by cables/wireless has more and more difficult to meet requirements of practical prospecting.

For example, remote transmission seismic apparatus by cables need to carry big bundles of cables to cliffy mountains. This results in a great amount use of labour power and transporting equipment, being very dangerous, frequently

happening of casualties, and damages of the equipment. In addition, it is frequently impossible to deploy cables to designed position as result of the limitation of the length of cables so that channels are emptied or lost.

Although a remote transmission seismic apparatus by wireless transmitting is convenient, the system usually loses channels and/or stations in a mountainous region as result of the blind regions of radio transmission. The workload is increased because very much electric energy consumed by wireless transmission needs heavy equipment of power supply. The efficiency of the deployment of wireless remote transmission seismic apparatus is lower and lower along with the increase of channels deployed because long time is needed for the real time data return transmission. The above two kinds of seismic apparatus have been very much difficult to meet the needs of the fieldwork when working in mountainous areas with very bad topography.

The applicants have invented remote transmission seismic apparatus using GPS satellite timing, which has “no

central units (main seismometer), no cables, and no radio stations, and is portable, cheap, and intelligentized” (The application numbers of Chinese patents are CN01134726.0 and CN02129603.0) for compensating the shortage of real time transmitting seismic apparatus in the art in the fields of system conveying, arranging cables for prospecting, data transmission, and communication. The remote transmission seismic apparatus using GPS satellite timing are especially suitable to seismic prospecting work in complicated areas because the apparatus has two kinds of working, one is timing data acquisition, and the other is continuous data acquisition, so that the working efficiency of seismic data acquisition in the fields is increased and the cost is decreased.

The non-real time transmission seismic data acquisition apparatus uses high accuracy GPS clock signals to synchronise the system clocks of every acquisition unit and remote detonating unit, and works in the ways of timed and synchronised detonating and recording. In operation, detonating and recording units, all operate according to flow chart designed

for the system without any artificially intervention. If the system operates 12 hours every day and acquires and records data for every minute, the numbers of original record files in every data acquisition unit every day are equal to  $12 \times 60$ , i.e., 720 original record files every day. If the system operates 12 hours every day and acquires and records data for every ten-second, the numbers of original record files in every data acquisition unit every day are equal to  $12 \times 60 \times 6$ , i.e., 4320 original record files every day. The numbers of original files in data acquisition units are more and more as the number of data acquisition units and the data acquisition time increase (increase by degrees of geometric series). Therefore, whether or not the present system is capable of being applied in practice, the key points are how to manage and safely retrieve these original record files.

### **SUMMARY OF THE INVENTION**

The data acquisition method of non-real time transmitting seismic data acquisition system applied in mountainous area of this invention may solve the following technical problems in non-real time transmitting seismic data

acquisition system: the safely and effectively managing of tens of thousands original record files, intelligentized retrieving record files in the acquisition unit, and permuting the data after retrieving.

The data acquisition method of non-real time transmitting seismic data acquisition system applied in mountainous area of this invention is as follows:

(1) using the eight digits file names representing absolute time together with three digits extension names representing equipment serial names as the format of original record file names, wherein the eight digits file names and three digits extension names consisting of Arabic numerals 0-9 and English letters;

(2) all original record files names in data acquisition unit being 8 + 3 digits file names and consisting of Arabic numerals 0-9 and English letters; the former eight digits representing years, months, days, hours, minutes, and seconds; and the latter three extension names digits representing the

equipment's serial number of data acquisition units;

(3) the detonating units generating SPS format (Shell's Processing Support Format ) spreadsheets of 3-D land seismic exploration assistant data according to file names generating method of the step (1), and at the same time, it is appointed that by means of distinguishing intermittence signals generated by the high voltage circuits in the detonating units, the operating systems in the detonating units write the effective explosion's absolute operating time into SPS format spreadsheets of 3-D land seismic exploration assistant data according to the detonating unit's file names generating method when there are intermittence signals, and not record the said absolute operating time in SPS format spreadsheets of 3-D land seismic exploration assistant data when there are no intermittence signals;

(4) combining the multiple detonating unit's SPS format spreadsheets of 3-D land seismic exploration assistant data according to SPS format spreadsheets of 3-D land seismic exploration assistant data, which are generated by the multiple detonating units to prepare for retrieving the data; while

retrieving, inputting the combined multiple detonating unit's SPS format spreadsheets of 3-D land seismic exploration assistant data into the data retrieve units, which consist of microprocessors with system bus;

The above file names effectively recorded in SPS format spreadsheets of 3-D land seismic exploration assistant data being on the basis of the former eight digits; connecting the data acquisition units and the data retrieve units by net lines in the way of network; operating the data retrieving programmes in the data retrieve units; connecting the data retrieve units and the data acquisition units with a special line; running the data retrieving programmes to complete the following operations:

a) searching the original files effectively recorded in the field acquisition units and copying them into the data retrieve units;

b) setting the original files as read-only attribute on the disks of computers in the field acquisition units to prevent to lose the data, and in that case, the data can be retrieved

again;

c) Deleting the great amount of unnecessary data to release the space of the disks so as to prepare for the next acquisition.

(5) arranging the data sequences indoors after the data retrieving operations; rearranging the original files data effectively recorded in the multiple data retrieve units into the format recorded in the unit of shots according to “the regulations of the same file names” on the basis of layout to provide to the system of processing data.

As hereinabove the data acquisition method of non-real time transmitting seismic data acquisition system applied in mountainous area, when the generation of original file names recorded in the data acquisition units are recorded once for every minute, the former eight digits have the following meaning: the first digit of the former eight digits represents years and consists of Arabic numerals and English letters, and is circularly used again and again for 36 years; the second digit represents months



and consists of Arabic numerals, and is denoted according to the practical calendar; the fifth and the sixth digits represent hours and consist of Arabic numerals, and is denoted according to the 24 hours system; and the seventh and the eighth digits represent minutes and consist of Arabic numerals, and is denoted according to the 60 minutes system.

As hereinabove the data acquisition method of non-real time transmitting seismic data acquisition system applied in mountainous area, when the generation of original file names recorded in the data acquisition units are recorded once for every ten-second, the former eight digits have the following meaning: the first digit of the former eight digits represents years and consists of English letters, and is circularly used again and again for 26 years; the second digit represents months and consists of Arabic numerals and English letters; the third digit represents days and consists of Arabic numerals and English letters, and is denoted according to the practical calendar; the fourth and the fifth digits represent hours and consist of Arabic numerals, and is denoted according to the 24 hours system; the sixth and the

seventh digits represent minutes and consist of Arabic numerals, and is denoted according to the 60 minutes system; and the eighth digit represents seconds; and every ten-second is used as a measure unit.

As hereinabove the data acquisition method of non-real time transmitting seismic data acquisition system applied in mountainous area, wherein the extension names of the detonating units are .XX, which denote the serial number of making the detonating units, and the latter two digits after the underline consist of Arabic numerals 0-9 and English letters, which are permuted and combined.

This invention has the following advantages and positive effects in comparison with the traditional seismic data acquisition methods:

It is realised to manage the original file data recorded in the data acquisition units effectively and safely by means of the original record file data acquisition method of non-real time transmitting seismic data acquisition apparatus. The method is

exclusive and feasible to manage and search and has solved the technically difficult problems of the data management for original record files and difficulties of retrieving data as result of non-real time transmitting characteristics of the system. The method may find the original file data (effective data) recorded in the every field data acquisition unit quickly and accurately and delete the unnecessary data acquired. The method realises the safe and intelligentized management of the original record file data of non-real time transmitting seismic data acquisition apparatus to provide safe and reliable managing mechanism for permuting and arranging the data at the latter time.

The present invention may be intelligentized without any artificially intervention if otherwise equipping with the special software and equipment for automatically permuting the data indoors so that this invention can also completes the whole process of seismic data acquisition in the field completed by the conventional real time data acquisition system.

## **DETAILED DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a block diagram of the circuits of the data retrieve unit according the invention;

FIG. 2 is a flow chart of the operation of the data acquisition units according the invention;

FIG. 3 is a flow chart of the operation of the detonating units according the invention;

FIG. 4 is a flow chart of the operation of the data retrieve units according the invention;

FIG. 5 is a flow chart of the operation of permuting the data indoors according the invention;

FIG. 6 is a block diagram of the structure of the detonating unit system according the invention;

FIG. 7 is a block diagram of the structure of the data acquisition unit system according the invention;

## **EMBODIMENTS OF THE INVENTION**

The modes and steps of embodying the invention in

detail are as follows:

1. The format of the file names of original record file are eight digits file names together with three digits extension names which consist of Arabic numerals 0-9 and English letters, i.e., XXXXXXXX.XXX.

The former eight file names digits represent absolute time.

The latter three extension names digits represent the equipment's serial number.

2. The regulations of generating file names of the data acquisition units.

The meanings of eight digits together with three digits file names

(A) The meaning of XXXXXXXX while recording once for every minute:

The first digit represents years and consists of Arabic numerals and English letters, and is circularly used again and

again for 36 years. It is appointed that the number 0 represents the 2000 year, the number 1 represents the 2001 year, the number 9 represents the 2009 year, the letter a represents the 2010 year, the letter b represents the 2011 year, ..... , and so on, the rest may be deduced by analogy.

The second digit represents months and consists of Arabic numerals and English letters. It is appointed that the number 1 represents January, the number 9 represents September, the letter a represents October, the letter b represents November, and the letter c represents December.

The third and fourth digits represent date and consist of Arabic numerals, and are denoted according to the practical calendar. It is appointed that the numbers 01 represent the first day in the calendar, and the numbers 31 represent the thirty-first day in the calendar.

The fifth and sixth digits represent hours and consist of Arabic numerals, and are denoted according to the 24 hours system. It is appointed that the numbers 00 represent 0 o'clock at

the midnight, the numbers 01 represent 1 o'clock a.m., ..... , and the numbers 23 represent 23 o'clock p.m..

The seventh and eighth digits represent minutes and consist of Arabic numerals, and are denoted according to the 60 minutes system. It is appointed that the numbers 00 represent zero minutes, the numbers 01 represent one minute, ..... , and the numbers 59 represent fifty-nine minutes.

Hence, for example, 3a231834.XXX represents the seismic records received (or the existent shooting) at eighteen o'clock thirty-four p.m. sharp on October 23<sup>rd</sup>, 2003.

(B) The meaning of XXXXXXXXX while recording once for every ten-second:

The first digit represents years and consists of English letters, and is circularly used again and again for 26 years. It is appointed that the letter a represents the 2001 year, the letter b represents the 2002 year, the letter c represents the 2003 year, ..... and so on, and the rest may be deduced by analogy.

The second digit represents months and consists of

Arabic numerals and English letters. It is appointed that the number 1 represents January, the number 9 represents September, the letter a represents October, the letter b represents November, and the letter c represents December.

The third digit represents days and consists of Arabic numerals, and is denoted according to the practical calendar. It is appointed that the number 1 represents the first day in the calendar, ..... , the number 9 represents the ninth day in the calendar, the letter a represents the tenth day in the calendar, the letter b represents the eleventh day in the calendar, ..... , and the letter v represents the thirty-first day in the calendar.

The fourth and fifth digits represent hours and consist of Arabic numerals, and are denoted according to the 24 hours system. It is appointed that the numbers 00 represent 0 o'clock at the midnight, the numbers 01 represent 1 o'clock a.m., and the numbers 23 represent 23 o'clock p.m..

The sixth and seventh digits represent minutes and consist of Arabic numerals, and are denoted according to the 60



minutes system. It is appointed that the numbers 00 represent zero minutes, the numbers 01 represent one minute,....., and the numbers 59 represent fifty-nine minutes.

The eighth digit represents seconds. Every ten-second is used as a measure unit. It is denoted that the number 0 represents 00 second, the number 1 represents 10 seconds,....., and the number 5 represents 50 seconds.

Hence, for example, cau18343.XXX represents the seismic records received (or the existent shooting) at eighteen o'clock thirty-four and thirty seconds p.m. sharp on October 30<sup>th</sup>, 2003.

The above two methods of managing files are distinguished by the first digit representing the years: 2009 ago, the former consists of Arabic numerals, and the latter starts with the English letters; after 2009, the difference between them is nine years so that the confusion with each other can not happens. Therefore, the file name is still “exclusive”.

### 3. The meaning of three extension names

(1) The three extension names of the data acquisitions units. XXX represent the equipment's serial number of the data acquisition units and consist of the permutation and combination of the Arabic numerals 0-9 and English letters. It is denoted that the first equipment is numbered as 001, 999 represents the product's serial number of the 999<sup>th</sup> equipment, 00a represents the product's serial number of the first thousand<sup>th</sup> equipment, ....., and so on, the rest may be deduced by analogy.

This nomenclature may generate  $36^3 = 46656$  names of the equipment. These names are enough to manage 139968 seismic traces.

(2) The extension names of the detonating units are .XX, denote the detonating unit's serial number, and consist of one underline and two characters. The two digits XX are consist of the permutation and combination of the Arabic numerals 0-9 and English letters.

4. The generation method of the operation files of the detonating units

The detonating unit consists of GPS receiving sections, industrial microcomputers, high voltage circuits, and A/D conversion circuits. The output of the high voltage circuits is connected to detonating ends of electric detonators. The operating systems in the detonating units operate by means of distinguishing intermittence signals generated by the high voltage circuits in the detonating units. When there are intermittence signals, the detonating units write the effective explosion's absolute operation time into SPS format spreadsheets of 3-D land seismic exploration assistant data according to the methods of generating file names of the detonating units; and when there are no intermittence signals, the detonating units do not record the said absolute operation time into SPS format spreadsheets of three dimensions seismic exploration assistant data. The SPS format spreadsheets of 3-D land seismic exploration assistant data are generated according to the generation methods of file names of the detonating units when the detonating units are operating, and at the same time, it is appointed that the effective explosion's absolute operation time is written into the SPS format

spreadsheets of 3-D land seismic exploration assistant data according to the generation methods of file names of the detonating units only when the detonating units detonate the explosive successfully, and when the operations are off and the detonation of the explosive is not successful, the absolute operation time is not recorded into the SPS format spreadsheets of 3-D land seismic exploration assistant data.

#### 5. The intelligentized retrieving of the data

The intelligentized retrieving of retrieving data is an application on the basis of the original record file data acquisition methods of non-real time transmitting seismic data acquisition apparatus. First of all, the SPS format spreadsheets of 3-D land seismic exploration assistant data of multiple detonating units are combined according to the SPS format spreadsheets of 3-D land seismic exploration assistant data generated by the detonating units so as to prepare for retrieving the data.

When retrieving, the combined SPS format spreadsheets of 3-D land seismic exploration assistant data of the

detonating units are put into the special data retrieve units. The data acquisition units and the special data retrieve units are connected by net lines in the form of network according to the file names (the former eight digits) effectively recorded in the SPS format spreadsheets of 3-D land seismic exploration assistant data while the detonating units are operating. The programmes of intelligentized retrieving data are run in the special data retrieve units. The field operators only connect the plugs of the special data retrieve units to the special plugs of the data acquisition units and initiate intelligentized retrieving programmes system so that the following operations are completed automatically:

1. According to the principles of “the same file names”, the original effective file data recorded in the data acquisition units are searched and copied to the data retrieve units.

2. The original effective file records are set as read-only attribute on the disks of the computers of the data acquisition units to prevent to lose the data, if the data would be lost, the data can also be retrieved.

3. The great amounts of unnecessary data acquired are deleted to release the space of the disks so as to prepare for the next recording.

The above data acquisition units consist of GPS receiving sections, industrial microcomputers, and A/D conversion circuits.